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Title: Dietary Transition in India: Temporal and Regional Trends, 1993-2012.

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Abstract

Background: Rapid economic growth, urbanization and globalization have resulted in dietary transformation in India. Triple burden of malnutrition remains a significant concern, with high prevalence of undernutrition, widespread micronutrient deficiencies and rising obesity.

Objective: This paper reviews the dietary transition in India by analysing trends in food consumption across time and space.

Methods: Household consumption survey data from 1993 to 2012 are analysed to examine both national and state level trends to investigate how diets have changed and vary across the country. Typical Indian diets are characterised using k-mean cluster analysis, and associated with socio-economic and geographical aspects.

Results: The paper finds that on average Indian household diets have diversified slowly but steadily since the nineties. Indians diets have shifted away from cereals to higher consumption of milk. However, progress on micronutrient-rich food groups such as fruits, vegetables, meat and egg has been worryingly slow. Even by 2012 about a fifth of rural Indian households did not consume fruits or milk, while more than half of both urban and rural households did not consume any meat, fish or eggs. Five predominant dietary types are identified. Sections of the Indian households do consume reasonably balanced diets, but large percentages consume cereal-focused, dairy-focused or processed foods heavy diets with high processed food content.

Conclusions: Diets in India have not transformed sufficiently to overcome major gaps in intakes of micronutrient rich foods. Large regional heterogeneities in diets call for regionally differentiated strategies to improve diets.

Keywords: dietary transition, India, dietary diversity, micronutrient deficiencies

Introduction

Following economic liberalization policies introduced in the early 1990s, India has experienced rapid economic growth, urbanization and globalization. However, malnutrition remains a significant concern in India, with the 2013-15 Rapid Survey of Children reporting stunting prevalence of 38.7% among under-fives [1], and widespread micronutrient deficiencies in the population [2]. The nutritional adequacy of Indian diets has therefore been the subject of debate, and much of this debate has revolved around energy intakes. In particular, attention has centred on explaining the puzzle of decreasing calorie intakes across income classes in spite of growth in household incomes [3 4]. Other work has described dietary transformation in the country [5 6], noting in particular the diversification out of staple grains and pulses and into more expensive sources of energy such as milk and meat. However, an apparent slowing of such diversification in the second half of the 2000s has been

observed [7]. Dietary quality improvements have been found to be insufficient, and micronutrient deficiencies remain widespread [2 8].

In this paper, we contribute to this literature by analysing trends in dietary diversity in India across space and time. An important aspect of our contribution is to examine regional differences in the evolution of diets at national level for India, on which relatively little attention has been focused in the previous literature. Given the size and diversity of India, nutrition-related outcomes and their drivers can vary substantially across states and regions, and national trends can mask large regional heterogeneities of relevance to policy and practice [9]. Also, by investigating trends based on household micro data from the National Sample Survey Organization (NSSO) over almost two decades from 1993-94 to 2011-12, we are able to capture medium to long-term temporal evolution in consumption pattern. Finally, we add to the literature by developing a data-defined typology of Indian diets and examining the characteristics of households consuming these typical diets. Our analysis holds relevance not only for the important case of India, but also for other South Asian countries experiencing economic, nutritional and epidemiological transitions.

The paper is structured as follows. Section 2 describes the data and methodology used in the paper. Section 3 presents the results, while section 4 provides discussion and conclusion.

Data and methods

Data

The paper uses various rounds of household consumer expenditure surveys (HCES) conducted by National Sample Survey Organization (NSSO). The NSSO conducts quinquennial surveys on consumer expenditure on various items including food and non-food expenditures. The quinquennial surveys, referred to as NSSO 'thick rounds', are nationally representative and have sample sizes of over 100,000 households. In this research, we focus particularly on the 50^{th} and 68^{th} thick rounds corresponding to

years 1993-94 and 2011-12 respectively. However, we also use data from the intermediate thick rounds and years for some of our analysis. NSSO surveys are comparable over the years with only minor changes in the food consumption questionnaire. Thick round data collection happens over quarterly sub-rounds to account for seasonality. The food questionnaire records both quantity and expenditure value of over 250 food and beverage items purchased over a recall period of 30 days [10]. In spite of some shortcomings[1], such as data collection on food purchases at household rather than individual level, recording of food purchases rather than intakes, and a relatively long recall period of 30 days, NSSO dietary data are considered a valuable source of information on Indian diets and have been used in many studies (*eg.* [3 7]).

Measuring household dietary diversity

Household dietary diversity is measured by the Household Dietary Diversity Score (HDDS) using the 12 food groups classification suggested by FANTA/USAID[2]. Each food group is categorized as 1 if the household consumes the food group and 0 if they do not consume it over a 30 day recall period. We also use estimate the per capita quantity of food consumed. It is calculated for each household by summing up the quantity of each food group and dividing by the household size.

The HDDS provides a simple, robust and easily interpretable indicator of dietary diversity at the household level, but it fails to capture the distribution of food groups consumed. Thus in this paper, dietary diversity is also measured using the Simpson index (SI). SI originates from the measurement of species diversity and economic competitiveness and has been applied previously as a measure of dietary diversity [11-13]. It is calculated as 1 minus the sum of squares of the expenditure shares (si) of food groups. A high score would indicate a diverse food basket, while a low score indicates a concentrated diet.

[1] For more details please refer to the Appendix.
[2] Classification of NSSO food questionnaire into FANTA classified food groups is provided in the Appendix.

$$SI = \left(1 - \sum s_i^2\right)$$

Identifying diets using cluster analysis methods

We use multivariate methods to define patterns in household dietary data by employing a clustering technique [14]. The objective is to group sampled households into clusters based on similarity of diets, allowing identification of distinct and predominant dietary patterns in the data. The method uses Euclidean distances between observations to empirically estimate clusters within a given dataset [15]. Analysis was conducted using partition cluster analysis, also known as the K-means method. Partition clustering is an iterative process that minimises within-cluster variability while maximising between-cluster variability at the same time. The technique assigns observations into a distinct number of non-overlapping clusters defined by researchers. Each observation is assigned to the cluster with the closest mean. New cluster means are then calculated after each observation is assigned. The process continues iteratively until no observations change clusters [16].

We started by including all 12 food groups to define clusters. Stepwise, we excluded individual food groups from the clustering criteria if they did not contribute to variations in dietary patterns. The final clustering criteria included shares of expenditure on starchy foods, vegetables, fruits, meat, egg, dairy and fish/seafood. Food groups with insufficient contribution to dietary variability and therefore not used as indicators in the clustering were: oils; spices, condiments & beverages; legumes, seeds and nuts and sweets. Expenditure shares for cereals and tubers were combined to constitute 'starchy foods'. The paper uses expenditure shares instead of quantity in order to compare minor changes in food item list in the survey questionnaire over time. Further, there are multiple units for different food items. For example, bananas and eggs were counted in numbers while milk was measured in litres and lentils in grams. Expenditure value provided a standard unit for all food items.

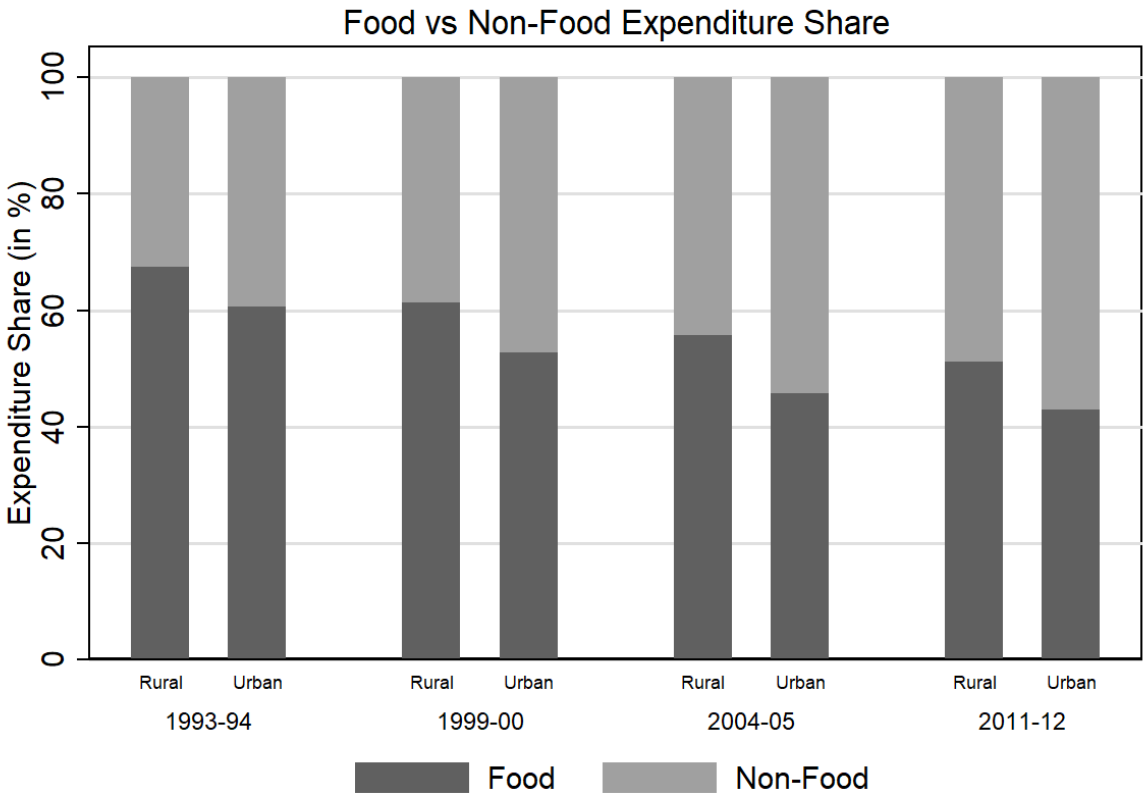
Results: Dietary Transition in India

Food consumption and dietary diversity

Expenditure on food

Figure 1 presents evolution of food expenditure at the national level over time. Expenditure on food is seen to comprise a large proportion of Indian household budgets. In 1993-94, both urban and rural households spent over 60% of their monthly expenditure on food. Since then, there has been a gradual decline in the food expenditure share. In 2011-12, rural households spent approximately half of their budget on food, while urban households spent a little over 40% on food.

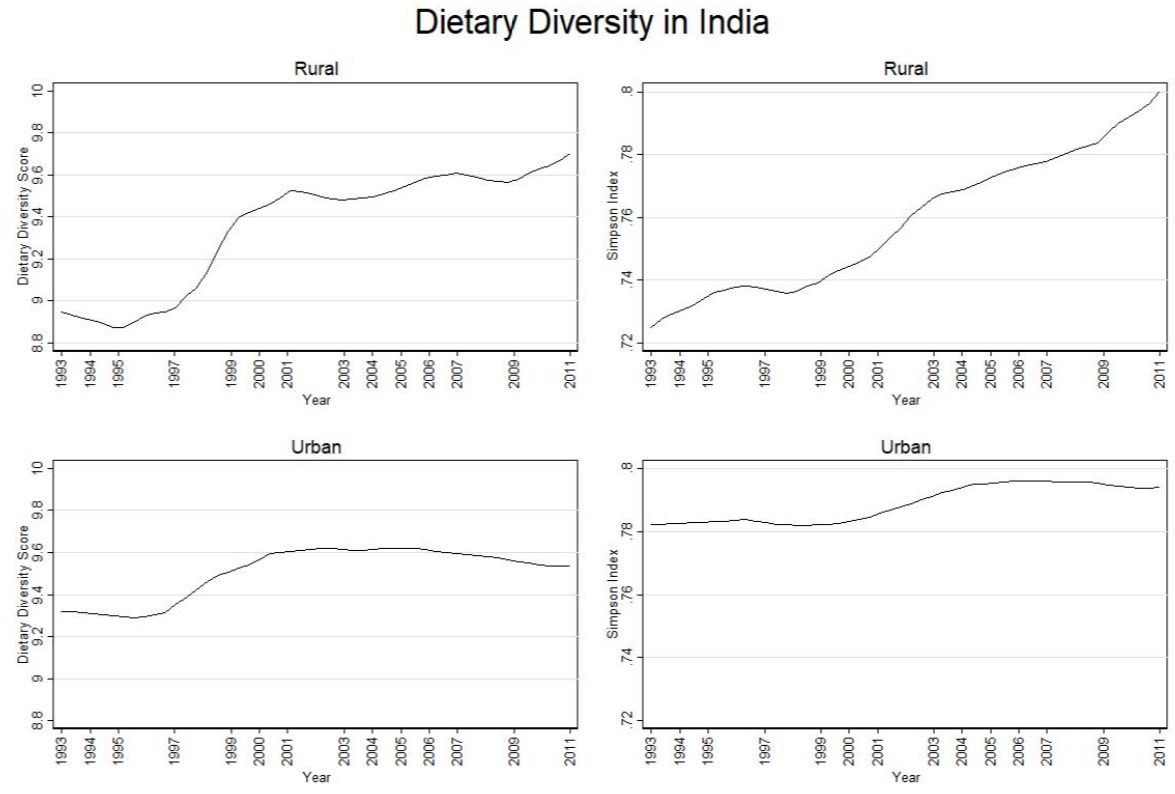
Figure 1: Household Expenditure Share on Food and Non-Food Items



Household dietary diversity

Figure 2 presents average household DDS and SI for both urban and rural India for the period 1993-94 to 2011-12. In 1993-94, rural households consumed 9.08 out of 12 food groups over the 30-day recall period, while urban households consumed approximately 9.34 food groups. By 2011-12, rural households consumed 9.71 food groups out of a total of 12 food groups on average, while urban households consumed approximately 9.57 food groups. Thus, dietary diversity for urban areas has only slightly improved over the two-decade period, while rural diets have improved by 0.63 food groups over this period, resulting in rural diets now being somewhat more diverse than urban diets on average. This pattern is also reflected in graphs for Simpson's Index, which show that SI for urban areas has inched up by 2% over the period, while the SI for rural India has increased by 8%.

Figure 2: Household Dietary Diversity in India (1993-2011)



1. Local polynomial curves
2. Missing years on x-axis refer to missing data points.

Figures 3 and 4 show state level variation in HDDS across India and its temporal evolution. Separate maps are presented for rural and urban India and for 1993-94 and 2011-12. We find clear regional patterns in diversity of rural diets as seen in Figure 3. Rural areas of the Southern peninsula and Eastern states along with Jammu and Kashmir display the highest household dietary diversity. The Northern, Western and Central regions of the country have relatively low dietary diversity scores. In terms of states, the Southern states of Kerala and Tamil Nadu and the Eastern state of Assam have consistently high diversity scores, while Rajasthan is amongst the states with least diverse diets in India. Rural diets are seen to have to have improved over time, with most Northern, central and Western states going past the threshold of 9 food groups during this period, and most Southern states exceeding a DDS of more than 10 by 2011-2012. Rajasthan and Haryana were the only two states with average DDS of less than 9 food groups in rural areas by 2011-12.

Figure 4 shows that DDS for urban India has a less clearly delineated regional pattern than for rural areas. Generally, urban areas of the Southern peninsula and Eastern states have more diverse diets than urban areas of the Northern belt and central Indian states. Western states have the least diverse urban diets within the country. Notably, there has been significant improvement in urban HH dietary diversity in two states that have historically scored poorly in social development indices, Bihar and Jharkhand, while urban Tamil Nadu has improved substantially to achieve an average DDS in excess of 10 food groups by 2011-12. However, urban diets have only shown marginal improvements in much of the rest of the country. In particular, urban Gujarat and Rajasthan continue to have average DDS below 9 food groups while urban Punjab has actually seen average DDS decline from 9.08 to 8.93 food groups over 1993-94 to 2011-12.

Figure 3: Spatial Variation in Rural Dietary Diversity

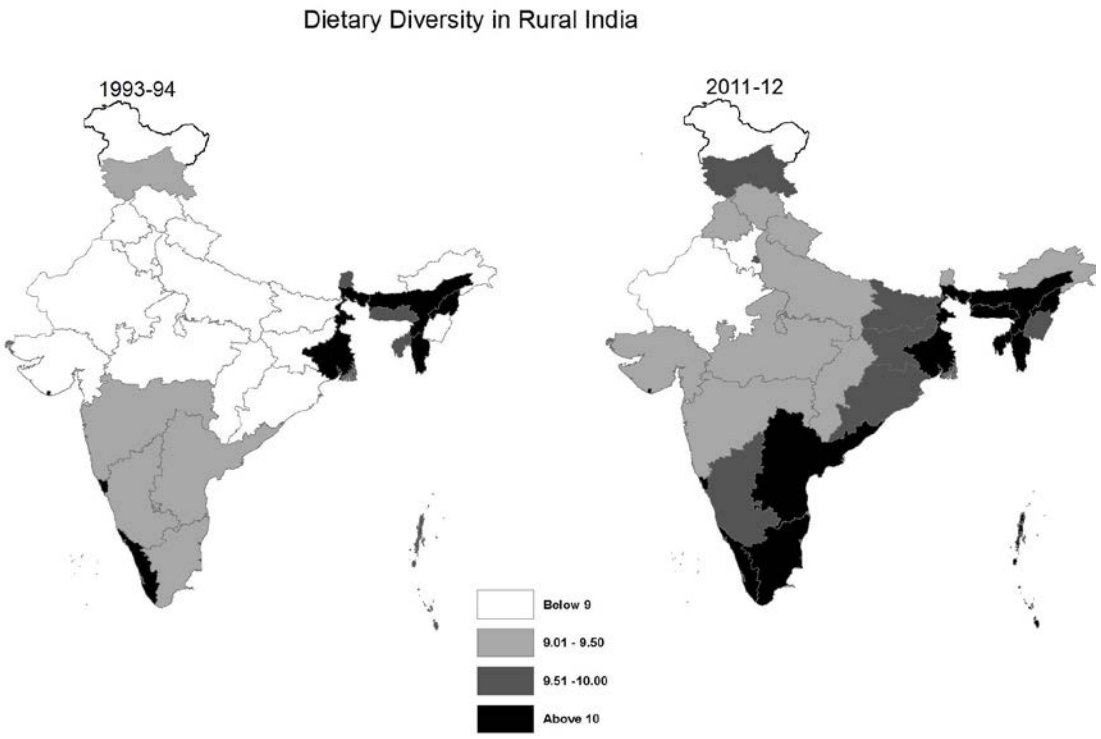
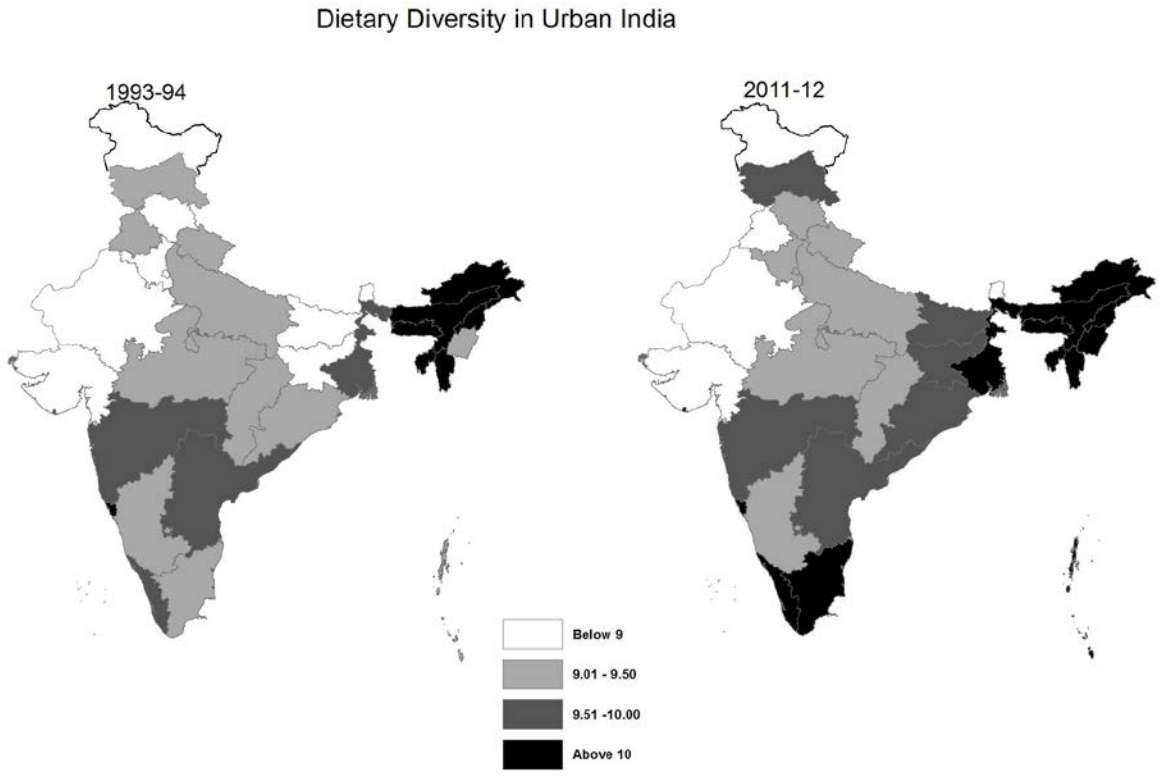


Figure 4: Spatial Variation in Urban Dietary Diversity



Consumption of individual food groups

We next turn to changes in the consumption of individual food groups in terms of per capita quantity as well as expenditure shares. Figure 5 and Figure 6 present changes to the per capita quantity of food consumed between 1993-94 and 2011-2012.

The decline in the importance of cereals is apparent. In 1993-94, rural Indian households consumed 450 grams per capita per day and urban households 350 grams (g). By 2011-12, this had declined to 380 and 300 g per day respectively. Consumption of all non-starchy[3] groups is lower in rural areas. Rural households on average consumed approximately 13 grams less vegetables, 20 grams less fruits and 42 grams less dairy products per day compared to urban households, even though their HDDS scores are on average now somewhat higher than for urban households.

Consumption of animal source foods has increased in consumption, from a very low base in the case of meat and egg. Consumption of dairy has increased significantly from 136 g/person/day for rural areas and 176 g for urban areas in 1993-94, to 155g and 197g respectively in 2011-12. Meat consumption in rural areas increased from 4.17 g/person/day in 1993-94 to 6.46 g. Urban India consumed 6.68 g/person/day of meat in 1993-94. This increased to 8.72 g in 2011-12. Similarly, rural consumption of eggs rose from 1.28 g to 2.36 g, while urban consumption increased from 3.00 to 3.99 g/person/day.

Per capita consumption of fish and seafood changed by less than a gram per capita per day over the two decade period. Rural intake stood at 7.25 g/capita/d in 1993-94 and 7.38 g/capita/d in 2011-12. Quantity of fish and seafood consumed more or less matched rural consumption and stood at 7.88g/capita/d in 1993-94 versus 7.25 g/capita/d in 2011-12. Consumption of pulses, nuts seeds and legumes has changed little over time.

[3] Starchy foods groups include cereals, roots, and tubers.

Next we turn to edible oils and sweets, key foods associated nutrition related chronic diseases. NSSO data shows that consumption of oil increased substantially over the two decades, from 13.1 to 21.9 g/capita/d in rural areas, and from 19.24 to 26.37 g/capita/d in urban areas. However, consumption of sweets remained fairly constant, with a slight rise from 26.80 to 27.05 g/capita/d in rural areas and a slight decline from 32.41 to 28.90 g/capita/d in urban areas.

Figure 5: Quantity of food consumed

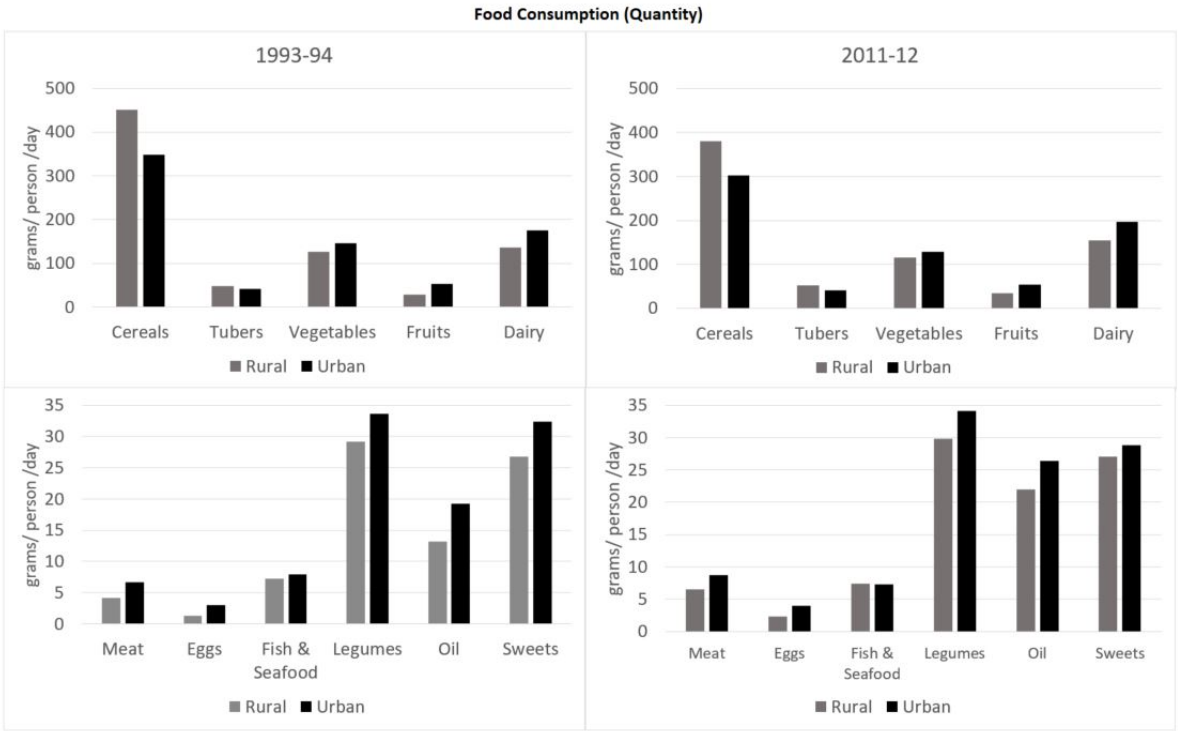
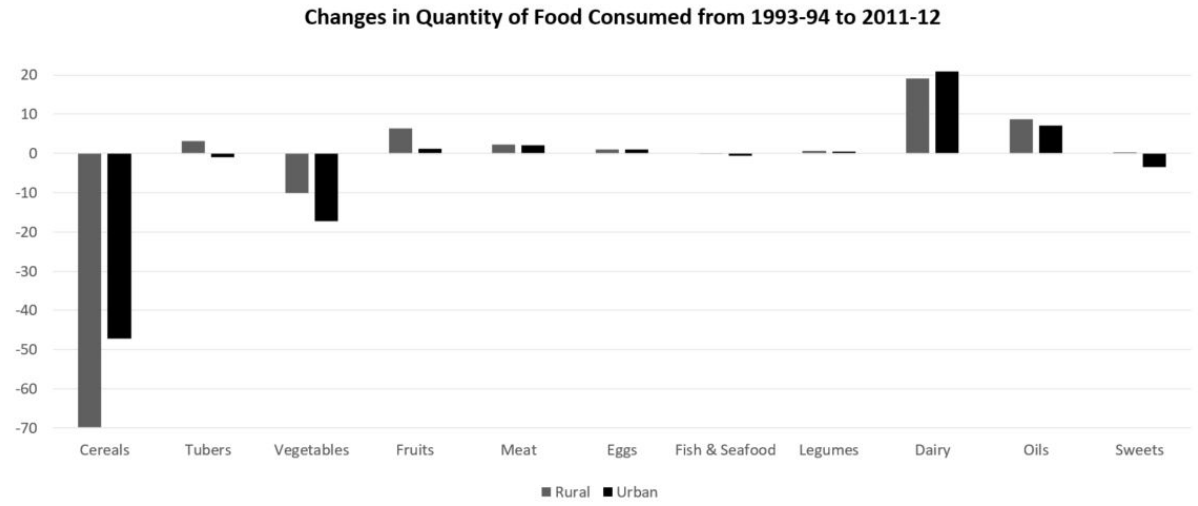


Figure 6: Changes to Quantity of Food Consumed



Figures 5 and 6 also indicate that fruit and vegetable consumption is quite low, and that there has actually been a decline in quantity of vegetables consumed and only a marginal increase in fruit consumption in the last two decades. Consumption of vegetables decreased from 125.81 g/capita/d to 115.67 g/capita/d in rural areas and from 145.99 to 128.71 g/capita/d in urban areas. Average fruit consumption increased from 27.93 to 34.27 g/capita/d in rural areas and 52.20 to 53.37 g/capita/d in urban areas. Consumption of fruits is remarkably lower in rural than in urban areas.

Figure 7 and Figure 8 present relative change in consumption of food groups within the context of overall food consumption, by presenting per capita expenditure on each group as a percentage of total food expenditure. In rural India, the importance of cereals has declined, going from 42% in 1993-94 to 27% of total food expenditure in 2011-12. Milk has experienced the largest gain, increasing from 12% to 17%. A range of other food groups have expanded marginally in the total budget share to make up the declining share of cereals – food groups such as oils, vegetables, meat and fish/seafood have expanded by 1 or 2 percentage points each in the rural budget shares. Urban budget shares have

shown less movement. As Figure 8 shows, share of cereals in urban food budgets has declined from 28 to 21%, while the share of milk has increased from 16% to 19%. Otherwise, apart from marginal increases in vegetable, fruit and meat shares, urban food expenditure shares have remained largely static.

Figure 7: Change in Food Budget Shares in Rural India (1993-94 to 2011-12)

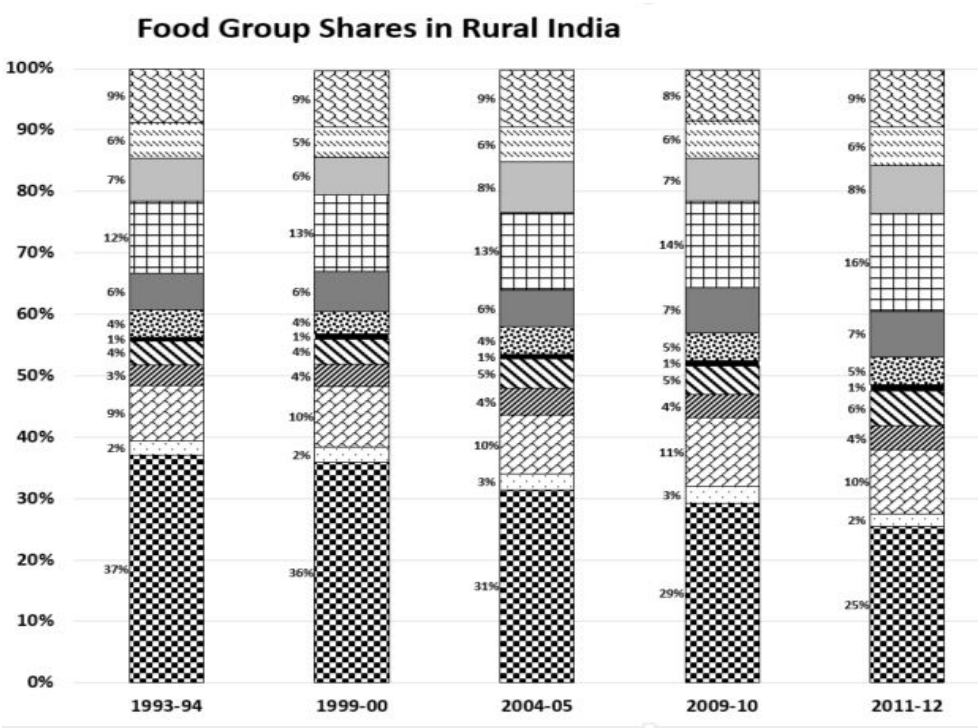
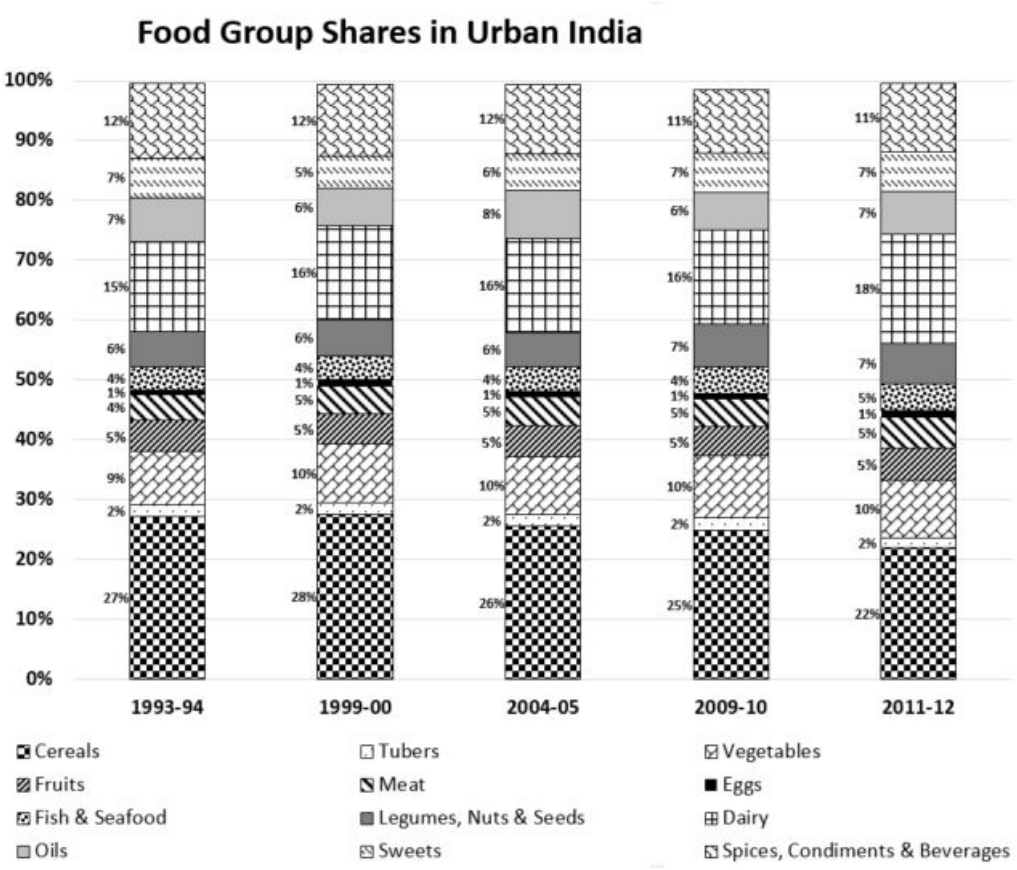


Figure 8: Change in Food Budget Shares in Urban India (1993-94 to 2011-12)



Note: The figures above represent mean household budget share values for each food group. Thus sum of all food group averages may not equal 100%.

Given the low levels of consumption and expenditure on micronutrient dense foods we next explore in Table 1 the proportion of households that did not consume specific food groups during the 30 day recall period in 2011-12. Table 1 also presents values for each dietary diversity indicator by region. We find that states in Eastern and Southern regions of India have more diverse diets than Northern and Western states by almost a whole food group on average. Southern India has the most diverse diets in terms of both indicators.

[Insert Table 1 here]

A large proportion of households did not consume food groups that are rich in micronutrients during the recall period in 2011-12. The rates of non-consumption of animal-source foods other than dairy are striking. For example, 51% households in India did not consume any meat products during the recall month in 2011-12, while 60% of households did not consume egg. While some of this may be

attributable to cultural and taste preferences such as vegetarian diets, non-consumption is also significant with certain other food groups. Even though milk is the second biggest contributor to Indian diets in terms of expenditure shares, 15% households did not consume it in the last 30 days in 2011-12. Despite the low and declining quantity of per capita vegetable consumption quantity, almost all households consumed vegetables in the month preceding the survey. However, approximately 17% of households did not report consumption of any fruits.

There exist regional differences too in the consumption of micronutrient-rich foods. Significantly higher proportions of households in the North and the West reported non-consumption of animal-source foods (other than dairy) compared to the South and the East. Non-consumption of any vegetables in the past-month was confined to a small minority across the country. However, the significant proportions of households in the East (30%), North (20%) as well as the West (15%) reported consuming no fruit at all in the recall period. In contrast, only 5% of households in the South reported non-consumption of fruit.

1.1.1. Household Dietary Diversity and Food Budget Shares by Income Groups

Table 2 presents HH dietary diversity and consumption patterns[4] by income[5] groups for 2011-12. Households are divided into quintiles based on monthly per capita expenditure using population weights. The share of starchy food groups is seen to decrease as income increases. While the poorest income group spent 38% of their food expenditure on cereals and roots & tubers, the richest spent less than a fifth. However, the relationship between dietary diversity and income is not linear. Diets become more diverse as income increases, but the richest quintile of households actually has less

[4] For the purpose of brevity FANTA classification of 12 foods groups are combined into five food groups in this sub-section. Firstly, cereals and tubers are summed and presented as cereals and tubers. Secondly, we do the same for fruits and vegetables. Thirdly, animal source foods includes the following FANTA food groups – dairy (previously mentioned as dairy in this paper), egg, meat and meat products, fish and seafood. Fourthly, we keep the classification of legumes, nuts and seeds as it is and finally, oils, sweets and spice, condiments and beverages are included in other foods. For further details on FANTA HHDS food group classification, please refer to Table 2: FANTA/USAID HDDS Food Group Categories.

[5] In line with the established convention in economics, monthly total expenditures are treated as a proxy for permanent income.

diverse diets than households with half their total expenditures. However, the richest groups in terms of expenditure do have the lowest expenditure shares on starchy food groups and highest for micronutrient rich foods such as fruits, vegetables and animal sourced foods.

[Insert table 2 here]

Dietary Patterns

Given the diversity in culture and food preferences in India [17] we next attempt to identify key patterns in diets across India. Results from the cluster analysis of dietary patterns are presented in Table 3. The cluster analysis identified five distinct types of dietary patterns in India for both 1993-94 and 2011-12 surveys. Furthermore, the five types of diets identified were consistent throughout the two decade period, i.e., no new dietary pattern emerged between 1993-94 and 2011-12. Below we describe the five diets in detail along with general characteristics of households consuming these diets. The identified diets are named according to the major distinguishing characteristic of the diet. For example, a diet that has the highest budget share for cereals across the five patterns is named cereals based diet. The other dietary clusters identified are: processed foods heavy diet; dairy based diet; balanced diet with dairy, and balanced diet with meat.

The cereal based diet is a traditional Indian diet that strongly relies on cereal consumption. At 43% in 2011-12, the mean value of food share of cereals was highest for this diet type. Expenditure on other food groups was relatively small. In 2011-12, approximately a fifth (19%) of the Indian population consumed the cereal based diet. The vast majority of households (87%) with this dietary pattern were based in rural areas, and about half were classified as agrarian households. Those consuming this diet had the lowest average incomes (in expenditure terms) compared to the other dietary groups. This diet was prominent in the East of the country - 43% of the household following the cereal based diet in 2011-12 were located in the East. Temporally, the prominence of cereals for this diet type declined over time in this diet, from 65% of the budget share in 1993-94 to 47% in 2011-12. Consumption of sweets, oils and spices, condiments & beverages has increased over time from 14% of the budget

share to 21%. The average land owned[6] by this group was 4.12 hectares in 2011-12, the second lowest amongt the five defined dietary pattern groups.

The second type of diet is categorised as a diet with processed foods due to the highest spending[7] on foods groups with processed foods. Food groups comprising sweets and spices, condiments & beverages constituted 11% and 23% of the food budget share respectively in 2011-12. This group spent the least on starchy foods and tubers. 8% of the sample consumed this diet in 2011-12. Although the group was distributed evenly across urban and rural areas, the majority of the households were based in the South in 2011-12. The proportion of households from the West consuming this diet declined from 15% in 1993-94 to 6% in 2011-12. Interestingly, diversity scores were amongt the lowest for this dietary pattern, while monthly per capita expenditure was highest and food budget share was the lowest. This group on average had the lowest land ownership and smallest household size.

The third type of diet includes a relatively large share of food expenditure on dairy products (42%) and thus is named dairy based diet. Starchy foods constituted a sixth (15%) of the food expenditure in 2011-12. This particular dietary pattern was less likely to include other animal source foods, such as fish and seafood, meat and egg. Even though this dietary type spent over 80% of its budget share of non-cereal foods, consumption of vegetables, fruits and legumes was lower than other dietary patterns observed. 15% of the sample population consumed this diet in 2011-12. This is predominantly a rural diet with 62% of these households based in rural areas, while 38% were urban households. Households were predominantly based in Northern India and the West.

The final two diet types were balanced diets, one with a greater proportion of dairy (33% of sample population) and the other with a greater proportion of meat (24% of sample population). The key distinguishing characteristic of these diets was a reasonably even spread of consumption proportion across food groups. In these groups, cereal proportions were neither as high as in the cereals based

[6] Monthly per capita expenditure, land ownership and household size are used as indicators of household assets and socio-economic status.
[7] In terms of food share.

diets, nor as low as in the processed food heavy diets. Balanced diets with dairy were more likely to be encountered in the North and West of the country, while balanced diets with meat were more prevalent in the South. The households in these groups had the highest dietary diversity scores amongt all the groups, and were typically located in the middle income quintiles.

[insert table 3 here]

The MPCE quintiles in table 2 presents all India values to descriptively showcase the variation in dietary diversity indicators and food consumption shares across expenditure/income groups. This table does not present the variation across rural and urban India nor does it present state level information. Thus, care must be taken in interpretting national level aggregates. These aggregates are not generalisable at household level. Especially as urban and rural realities differ considerably in India. This is a limitation of the paper. However, the national level analysis contributes to literature by showcasing temproal and spatial understanding of food consumption and dietary patterns at a macro level in India.

Discussion and Conclusion

This paper has explored trends in household dietary diversity in India across space and time. We have examined trends over almost two decades across the Indian states and regions using nationally representative data, and have uncovered predominant dietary patterns in the country and how they overlay with socio-economic status and geographical regions.

Indian diets have slowly but steadily diversified since the 1990s, with rural diets becoming more diverse than urban by 2011-12. Two key shifts in consumption patterns have been observed that have also been commented on by other authors [5 8]. Firstly, dependence on cereals has declined. Secondly, consumption of dairy foods has risen. However, although diets have diversified since the nineties, consumption of micronutrient foods remains dismally low especially in rural areas. Even by 2012, a significant proportion of the Indian population was unable to consume fruits, milk, meat,

fish/seafood or egg. Consumption of legumes has stagnated. At the same time, some foods associated with chronic diseases, such as edible oil, have expanded considerably in Indian diets.

The extent to which India continues to lag behind other parts of the world with respect to consumption of key micronutrient-rich foods is striking. Average 2011-12 fruit and vegetable consumption of 154 g/person/day in rural areas, and 181 g/person/day in urban areas as reported here is less than half the 400 g/person/day recommended by the WHO and FAO [18]. Particularly worrying is our finding that vegetable consumption has actually declined since the early 1990s. Meat consumption, at 6 g/person/day in rural areas and 8 g/person/day in urban areas in 2011-12, has increased over the two decades. Meat intake in India is a fraction of the intakes in the rest of Asia and very low even compared to its neighbours in South Asia (Flores-Martinez, 2016). This is particularly concerning given that less than 30%[8] of the Indian population above the age of 15 years is actuallly vegetarian [19]. In a country where anemia amongt women is endemic, the lack of bioavailable iron via meats in the diet is a concern.

We have identified five predominant dietary patterns in India, namely –cereal-based diet, processed foods heavy diet; dairy diet; balanced diet with dairy; and balanced diet with meat. Broadly, these dietary patterns have remained the same over the two-decade period studied suggesting habit persistence. The traditional cereal-based diets is predominant in rural areas, particularly amongst agricultural households with low incomes (in expenditure terms) and land endowments. The dairy diet is common in higher income rural households. It involves lower cereal consumption and higher dairy intake than the traditional cereals diet, but does not involve improved intakes of other foods. The processed foods heavy diet can be found in both urban as well as rural areas, and in contrast to the cereal-based diet, is consumed largely by higher income households. The remaining two clusters, 'balanced diet with dairy' and 'balanced diet with meat', present better dietary diversification and are

[8] 28.4% of men and 29.3% of women above the age of 15 years were estimated to be vegetarian in 2014 19. Government of India. Sample registration system baseline survey 2014, 2014.

consumed by a significant proportion of the population, particularly from the middle income quintiles. These diets provide an indication of the feasibility for improved diets in India taking into account socio-economic and cultural constraints.

Several policy and research implications follow from this research. Unsurprisingly, there is a strong regional dimension to Indian diets and dietary adequacy. In terms of targeting, a focus on the North and the West is advisable, where dietary diversity is lowest and diversifcation from traditional cereal-based diets tends to be limited to an expansion in dairy food intake. The South, and to a lesser extent, the East, are on better dietary trajectories.

Secondly, a particular effort is needed to improve fruit, vegetable and meat intakes in India. Several factors underlie low observed historical intakes of F&V and meat, including poverty, habits, culture, and government strategies and policies. Sustained economic growth in the country has increased demand, boosting the potential of 'high value' agriculture, including F&V and meat production, for smallholders. High transactions costs of linking smallholders to markets and inadequate infrastructure have been identified as major obstacles to producer response [20 21]. Gandhi and Namboodri [22] characterise F&V value chains in India as highly inefficient marketing structures with numerous poorly coordinated middlemen, limited flows of information, and high proportions of spoilage due to inadequate infrastructure. A concerted research as well as policymaking effort focused on overcoming these constraints to deliver reliable, safe and inexpensive supplies of fruit, vegetable and meat supplies remains important.

Thirdly, and related to the point above, policy debates on Indian agriculture and food systems have tended to revolve around food security and poverty and hunger eradication aims. This is understandable, as feeding India's large, growing and predominalty poor population has historically been a fundamental and monumental challenge. As several authors have pointed out [23 24], the research and policy focus has overwhelmingly been on calorie (and cereal) provision, with a corresponding neglect of dietary quality and provision of micronutrient rich foods in Indian diets.

However, as incomes have improved in India and important strides have been made towards food security, improvement in dietary quality must become an additional aim.

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Appendix

NSSO Data

This section sheds light on the various characteristics and limitations of the dataset.

Comparability between the Various HCES Rounds: The food expenditure questionnaires used in thin and thick rounds have remained comparable over time. Although minor changes have occurred with the addition of new food items, the changes in food questionnaire do not affect the analysis of dietary diversity conducted in this thesis as the analysis relies on number of food groups rather than individual food items. Further,this paper mainly relies on food expenditure shares and quantities are used in one section only.

Recall/Reference Period**:** Traditionally the reference period for food sub-questionnaire of HCES conducted by NSSO has been 30 days. A 30 day recall period is often criticised by nutritionists for being too long [25], especially to capture food consumption. Although the NSSO experimented with shorter recall periods between 1994 and 1998 (Rounds 51-54) they found that the surveys with shorter recall period reported average consumption of 15-18% higher than those surveyed using the traditional reference period of 30 days [26]. Thus, these rounds are not strictly comparable with the rest of the survey rounds.

Even though 24-hour recall food frequency questionnaires are the gold standards for food consumption advocated by nutritionists, the dearth of such survey data has proved to be an impediment to evidence-based food and nutrition policy [25]. Fiedler, et al. [25] conducted a review of HCES from low and middle incomes to find that HCES are a good alternative to 24-hour recall food-frequency questionnaires where data are lacking, specifically in the longitudinal context. Furthermore, in recent paper [27] comparing various data soruces for dietary intake in Indian population identified NSSO HCES to be a good data source at national level. Therefore, the use of NSSO surveys is appropriate in the given context of this paper, where the authors explore temporal variation in dietary transition for India.

Household Dietary Diversity Score (HDDS)

As the unit of survey data collection is a household this thesis estimates dietary diversity at household level. The household dietary diversity score (HDDS) is based on the guidelines provided by Food and Nutrition Technical Assistance Project (FANTA) funded by USAID. Swindale and Bilinsky [28] provide a sample questionnaire, where they categorise food items into 12 food groups for FANTA. The food groups are summarised in Table 4.

[Insert table 4 here]

Tables

Table 1: Percentage of Households That Did Not Consume Specific Food Groups in the last 30 days in 2011-12

	North	South	East	West	India
Cereals	2%	5%	1%	4%	3%
Tubers	2%	16%	2%	5%	6%
Vegetables	2%	5%	2%	4%	3%
Fruits	20%	5%	30%	15%	17%
Meat	71%	29%	42%	65%	51%
Eggs	79%	36%	50%	76%	60%
Fish & Seafood	89%	66%	30%	86%	68%
Legumes	2%	5%	2%	4%	3%
Dairy	9%	10%	29%	14%	15%
Oils	2%	5%	2%	4%	3%
Sweets	1%	3%	1%	2%	2%
Spices, Condiments & Beverages	0%	1%	1%	1%	1%
DDS	9.21	10.14	10.09	9.20	9.66
Simpson Index	0.79	0.82	0.79	0.80	0.80

Table 2: Dietary diversity by income groups in 2011-12

Income Groups	Poorest - 1	2	3	4	5- Richest	India
Monthly Per Capita Expenditure	660	972	1,303	1,852	4,404	1,838
Dietary Diversity Score	9.24	9.79	9.92	9.96	9.41	9.66
Simpson Index	0.78	0.81	0.81	0.81	0.78	0.80
Cereals & Tubers	38%	31%	28%	24%	19%	28%
Fruits & Vegetables	13%	13%	13%	14%	16%	14%
Animal Source Foods	16%	23%	27%	30%	30%	25%
Legumes	9%	9%	8%	8%	7%	8%
Other	25%	24%	24%	24%	28%	25%

Table 3: Dietary Patterns in India

	1993-94						2011-12					
	Cereals Based	Processed Foods Heavy	Dairy Based	Balanced Diet with Dairy	Balanced Diet with Meat	Total	Cereals Based	Processed Foods Heavy	Dairy Based	Balanced Diet with Dairy	Balanced Diet with Meat	Total
Sample population	23%	11%	12%	23%	31%	100%	19%	8%	15%	33%	24%	100%
Dietary Diversity Score	8.43	8.87	8.83	9.53	9.60	9.15	9.51	8.09	9.09	9.90	10.36	9.66
Share of Non-Cereal Foods	35%	79%	80%	68%	56%	59%	53%	85%	83%	74%	72%	72%
Simpson Index	0.59	0.77	0.75	0.81	0.77	0.73	0.76	0.72	0.75	0.83	0.84	0.80
Expenditure Share of Key Food Groups												
Cereals	62%	17%	18%	30%	42%	38%	43%	10%	15%	24%	26%	25%
Tubers	4%	2%	2%	2%	3%	3%	4%	1%	2%	2%	2%	3%
Vegetables	8%	9%	7%	8%	9%	8%	10%	6%	7%	9%	12%	9%
Fruits	1%	9%	4%	3%	3%	3%	2%	12%	4%	4%	4%	4%
Meat	1%	5%	1%	2%	4%	3%	3%	4%	1%	4%	8%	4%
Eggs	0%	1%	0%	0%	1%	0%	1%	1%	0%	1%	1%	1%
Fish & Seafood	2%	4%	0%	1%	3%	2%	4%	10%	0%	1%	3%	3%
Legumes	6%	7%	6%	8%	8%	7%	8%	5%	6%	9%	10%	8%
Dairy	2%	9%	40%	21%	6%	13%	5%	7%	42%	23%	8%	18%
Oils	6%	8%	7%	9%	8%	8%	9%	5%	7%	9%	10%	8%
Sweets	3%	8%	8%	7%	6%	6%	5%	11%	7%	6%	6%	7%
Spices, Condiments & Beverages	5%	19%	8%	8%	9%	9%	7%	23%	8%	9%	10%	10%
Household Charateristics												
Monthly Per Capita Expenditure*	211	593	563	382	294	360	706	2435	1835	1395	1111	1345
Food Expenditure Share	71%	60%	63%	64%	66%	66%	54%	48%	47%	47%	49%	49%
Household Size	5	4	5	5	5	5	5	3	5	5	4	4
Land Owned (in hectares)	0.55	0.42	1.39	1.03	0.63	0.77	0.41	0.22	1.03	0.62	0.45	0.57
Location												
Rural	93%	48%	61%	66%	79%	73%	87%	51%	62%	63%	73%	69%
Urban	7%	52%	39%	34%	21%	27%	13%	49%	38%	37%	27%	31%
Religion												
Hindu	86%	77%	84%	86%	84%	84%	83%	77%	85%	85%	81%	83%
Other	14%	23%	16%	14%	16%	16%	17%	23%	15%	15%	19%	17%
Social Group												
Scheduled Tribe	16%	8%	3%	6%	10%	9%	14%	7%	5%	6%	13%	9%
Schedule Caste	30%	14%	11%	16%	22%	20%	25%	14%	15%	17%	21%	19%
Other Backward Class							38%	45%	38%	47%	44%	43%
Others	55%	78%	86%	79%	68%	71%	23%	34%	43%	30%	23%	29%
Rural Occupation												
Agricultural Households	70%	23%	42%	43%	51%	49%	50%	16%	36%	36%	42%	38%
Non-agricultural Households	21%	21%	18%	21%	24%	22%	36%	35%	26%	27%	31%	30%
Regional Distribution of Households												
North	15%	6%	28%	30%	20%	22%	15%	2%	33%	37%	12%	22%
South	12%	16%	2%	21%	50%	26%	7%	18%	3%	37%	35%	25%
East	54%	6%	1%	9%	30%	25%	47%	7%	2%	18%	26%	25%
West	10%	15%	18%	33%	24%	27%	10%	6%	23%	39%	22%	28%

* In Rupees at constant prices. Base year 1993-94.

Table 4: FANTA/USAID HDDS Food Group Categories

	Food Group	Constituents
Staples	Cereals	Corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products)
	White Tubers and Roots†	White potatoes, white yam, white cassava, or other foods made from roots
Fruits and Vegetables	Vegetables	Vitamin A rich vegetables and tubers: pumpkin, carrot, squash Dark green leafy vegetables: dark green leafy vegetables, including wild forms + locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach Other vegetables: (e.g. tomato, onion, eggplant) + other locally available vegetables
	Fruits	Vitamin A rich fruits: ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits Other fruits: including wild fruits and 100% fruit juice made from these
Animal Source Foods	Meat	Organ meat: liver, kidney, heart or other organ meats or blood-based foods Flesh meats: beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects
	Eggs	Eggs from chicken, duck, guinea fowl or any other egg
	Fish and Other Seafood*	Fresh or dried fish or shellfish
	Milk and Milk Products◦	Milk, cheese, yogurt or other milk products
Pulses	Legumes, Nuts and Seeds	Dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. hummus, peanut butter)
Others	Oils and Fatsɵ	Oil, fats or butter added to food or used for cooking
	Sweets	Sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes
	Spices, Condiments and Beverages	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, etc

Notes:
† Referred to as Tubers going forward
* Referred to as Fish & Seafood going forward
◦ Referred to as Dairy going forward
ɵ Referred to as Oils going forward

Authors' Note:

MT and BS conceptualised and designed the study. MT analysed the study and wrote the first draft.

BS and SK reviewed subsequent versions and added policy recommendations.

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